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CC188 The Sedimentation Test of Wheat Quality

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THE SEDIMENTATION TEST OF WHEAT QUALITY

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Why the Sedimentation Program

The U.S. Department of Agriculture announced plans in August, 1961, to pay premiums in the price-support program for high quality hard red winter and hard red spring wheats based on the sedimentation test. According to the USDA, the premiums were needed to encourage production of more high quality wheat, both for domestic use and for export.

The USDA listed these additional reasons for putting the sedimentation program into operation beginning with the 1962 wheat crop:

1. There is a wide variation in the quality of wheat produced in the United States. Present marketing operations provide little incentive for producers to up-grade the general quality level of U.S. bread wheat production.

2. The domestic market tends to utilize the high quality wheat leaving a poorer quality residue for storage by the Commodity Credit Corporation.

3. While the domestic needs for quality are paramount, the U.S. competitive position in dollar export markets has been weakened by difficulty in obtaining the higher quality wheat needed to fill export demand, particularly for hard red winter wheat.

Payment of price premiums to encourage production of higher quality wheat is believed to be a more desirable approach than the assessment of discounts. Discounts on undesirable baking varieties which have been included in the support program for several years will continue to be in effect, however.

A Description of the Test

The sedimentation test is not new. Cereal chemists have been familiar with the test for many years. Experiments on gluten swelling in various acids were conducted at the Nebraska Agricultural Experiment Station and elsewhere 40 years ago.

The sedimentation test is described as a simple and rapid method for estimating the quantity and quality of wheat protein. It does not require elaborate milling equipment needed for bread-baking or mechanical dough testing. Advocates of the test believe it provides a better measure of the overall bread-baking strength of wheat than any other known single test except actual bread-baking.

It is claimed that sedimentation values are related to loaf volume and thus to baking strength. The test is based on two known facts: (1) that gluten protein absorbs water and swells enormously when treated with lactic acid under certain conditions, and (2) that the amount of water absorbed, and consequently, the extent of the swelling, depends upon the "quality" of the gluten. Good quality gluten (from a bread-baking standpoint) absorbs more water and thus swells more than poor quality gluten.

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In making the test, a crude white flour is first obtained by grinding and sieving about 200 grams of wheat using prescribed equipment and procedures. A weighed portion of the flour is placed in a graduated glass cylinder and mixed with water. After a period of time a lactic acid solution is added. Following shaking and allowing to stand for prescribed periods of time the sediment in the cylinder is read in milliliters. This volume is known as the sedimentation value.

Proper grinding and accurate timing of operations are important in securing reliable test results. The USDA leaflet "How to Test for Baking Quality in Wheat (Sedimentation Test)" contains a brief description of the procedure.

How the Program Will Work

Sedimentation value rather than protein content will be used as a quality factor in administering the 1962 wheat-support program. Warehousemen will be offered the option of delivering wheat to CCC on the basis of either sedimentation or protein.

The sedimentation premiums will be at the rate of three cents for wheat testing 40-42 and one cent per bushel for each additional point of sedimentation value up to a maximum of 25 cents per bushel for values at 64 and above. Sedimentation values of 39 and below will receive no premiums. This schedule of values replaces the earlier announced schedule which provided for premiums based upon ranges of five units of sedimentation value.

A sedimentation test will be made by ASCS on all farm-stored 1962 wheat placed under the loan. This service will be given the farmer without charge. Producers who take out loans on warehouse-stored wheat will be offered price-support loans on the basis of sedimentation values recorded on the storage documents by the warehouseman.

Warehousemen must indicate, prior to harvest, whether they will deliver price-support wheat to CCC on the basis of sedimentation or protein. The warehouseman's election will be binding on all price-support wheat accepted for storage.

If the warehouseman elects sedimentation, the sedimentation value of the wheat will establish the loan value of the wheat to the producer and also the warehouseman's liability. In such instances, sedimentation value will be established on the basis which is mutually agreeable to both the producer and the warehouseman.

When the warehouseman has elected to be held accountable only for protein, both the sedimentation value and the protein content will be established by an authorized laboratory. The producer is paid on sedimentation and the warehouseman delivers on protein. Failure to secure both the required tests at the time of delivery to the warehouse will render the wheat ineligible for any premiums.

Wheat on which the warehouseman has elected to be held liable for sedimentation will be eligible for a three unit tolerance at the time of delivery to CCC. The tolerance is to compensate for test variations and other factors. The current tolerance provision on protein is .3 per cent. This would convert to approximately 1.75 points in sedimentation units. (1 per cent protein is roughly equal to 5.8 sedimentation units.)

Limitations of the Test

Considerable controversy has developed regarding the accuracy and application of the sedimentation test. Some possible test limitations are:

1. The sedimentation test may not be greatly superior to the protein test in estimating bread-baking quality of any lot of wheat. Tests in the past have shown

that in certain seasons the sedimentation test was a more accurate indication of baking quality than the protein test. In other seasons the reverse has been true.

2. Losses in sedimentation value may occur in newly harvested wheat under certain conditions during the first two or three months of storage.

3. Wheat with different sedimentation values may not always blend to a mathematical average.

4. Differences in results obtained between operators and laboratories may be sufficient to change the premium value on a lot of wheat.

5. The special equipment required for making the test will be an added expense for the grain handler. The charge for the sedimentation test in commercial laboratories will be slightly higher than for the protein test.

6. There is difficulty in obtaining a representative sample from the lot of wheat to be tested. This problem is no more serious with the sedimentation test, however, than with the protein test or with other chemical determinations.

Factors Affecting Test

The baking characteristics (quality) of wheat--and also the sedimentation value--is determined by (1) the variety and (2) the conditions under which the crop is grown. Dr. Zeleny, Agricultural Marketing Service, U.S.D.A., who developed the test, has made the following statement regarding factors which influence sedimentation results: "Environmental conditions during the growing period have a greater influence than variety on sedimentation values of wheat. Hard red winter wheat sedimentation values vary from less than 20 to more than 60, and with few exceptions, all varieties may fall into almost any part of this range, depending on the conditions under which they are grown."

Cultural practices, soil fertility, heat, drought, disease, and other factors can affect gluten quality and thus influence sedimentation value.

Sedimentation Values of Nebraska Varieties

Given growing conditions that produce an adequate amount of protein, it appears that any of the Nebraska-recommended varieties can produce a sedimentation value of 40 or above. Strong gluten varieties such as Cheyenne, Bison, Nebred, Warrior and Ponca ordinarily would be expected to produce higher sedimentation values than the mellow gluten varieties Pawnee, Omaha and Ottawa. However, there may be exceptions, and several years study will be necessary to get a relative comparison of the sedimentation potential for Nebraska varieties. With adequate protein it is possible for the mellow gluten varieties to qualify for premiums. Strong gluten varieties may fail to qualify for premiums if they are low in protein.

The relative sedimentation values of varieties may vary from year to year, depending on how they respond to the prevailing environmental conditions which modify protein quality. For example, heat and low humidity during the ripening period may adversely affect protein quality and thus sedimentation to varying degrees depending upon relative maturity.

Protein and sedimentation tests were made by the Wheat Quality Laboratory on the 204 wheat samples exhibited at the 1961 Nebraska Wheat Show. These tests showed a wide range in both protein percentage and sedimentation value within each variety. Average protein contents and sedimentation values of the 1961 crop were relatively low.

Wheat Show samples of Bison and Omaha with a protein content of about 11 per cent gave sedimentation values in the 40 range. Cheyenne samples, however, yielded values of 40 only when the protein content approached 12 per cent. The number of Cheyenne samples having protein between 10 and 12 per cent were relatively few compared to Bison and Omaha samples in this range. Nevertheless, results indicated that Bison and Omaha gave higher sedimentation values at a given protein level in 1961 than did Cheyenne. Other varieties grown in Nebraska were included in the testing program but the number of samples was not sufficient to draw similar conclusions.

To compare the gluten quality of different wheat varieties by means of sedimentation values, it has been suggested that sedimentation values be calculated to a constant protein basis. Such calculations were made to convert average variety sedimentation values of samples from the 1961 Nebraska Wheat Show to a 12 per cent protein basis. (Table 1).

Table 1. Average protein per cent and sedimentation values of selected varieties exhibited at the Nebraska Wheat Show, along with average sedimentation values when converted to a 12% protein basis.

Variety	No. of Samples	Average Protein Per Cent	Average Sedimentation	Average Sedimentation Value at 12% Protein*
Warrior	16	9.3	30.9	46.6
Bison	51	10.0	34.6	46.2
Nebred	10	10.5	36.7	45.4
Cheyenne	30	10.5	36.1	44.8
Omaha	50	10.9	36.8	43.2
Pawnee	25	9.4	25.0	40.1

* One per cent protein is roughly equal to 5.8 sedimentation value.

Although 1961 results indicate that some varieties may tend to give higher sedimentation values than others, it must be recognized that environment influences results a great deal. The same wheat varieties would not be expected to produce sedimentation values in the same order from year to year when converted to a constant protein level. Ordinarily, it would not be profitable to select a wheat variety on its potential sedimentation value alone. Higher yield of an adapted variety usually will more than offset any expected premium gained from an unadapted variety showing promise of giving a higher sedimentation value.

Preliminary evidence indicates that the most effective approach for production of wheat with high sedimentation value is through sound cultural practices applied to the recommended varieties.

Cultural Practices Which may Affect Sedimentation Value

Application of Fertilizer

Cultural practices which tend to increase protein per cent of the wheat can be expected to give higher sedimentation values. The use of nitrogen fertilizer in conjunction with recommended and timely cultural practices appears to be the best approach

that a grower can use to increase his chances for premiums under the sedimentation program.

Nebraska tests show that only small differences occur in yield between fall, spring and split applications when optimum rates of nitrogen fertilizer are used on wheat. However, spring application of nitrogen fertilizer has more effect than fall application on the protein content. Early spring treatment (before April 20) has more effect on yield and less effect on protein than late topdressing (after May 1). A combination of early and late spring topdressings may give good increases in both yield and protein content. Such increases are not always profitable to the producer.

Results of 52 Nebraska tests in a five-year period show that the time of nitrogen fertilizer application influences the protein content of the grain as given in Table 2. In each test fertilizer containing 30 pounds of available phosphate was drilled in with the seed, and fertilizer carrying 40 pounds of nitrogen per acre was applied at the indicated times. The split application consisted of 10 + 30 + 0 with the seed plus 30 + 0 + 0 topdressed in the spring. Fall applications of nitrogen fertilizer were broadcast just after seeding. Spring topdressing was done before the middle of April.

Table 2. Effects of nitrogen fertilizer on yield and protein of wheat. Average of 52 Nebraska tests, 1948-52.

Time	Yield	Protein
None	25 bu.	11.1%
Fall	32 bu.	11.7%
Spring	31 bu.	12.2%
Split	32 bu.	11.8%

Outstate tests in Nebraska since these data were obtained have given similar results.

Spraying the growing wheat in May or early June with urea solution has been reported effective in raising the protein content of the grain. Nitrogen fertilizer applied in this way at flowering time reportedly gives the largest increase in protein content. The practice may or may not be profitable.

Other Cultural Practices

Limited studies indicate that other practices such as date of seeding, chemical weed control, and date of harvest may affect sedimentation results. Further study is needed to determine to what extent these practices may be practical for increasing sedimentation values of wheat grown under Nebraska conditions.

Although there is evidence that date of seeding does influence sedimentation values, additional factors must be considered in choosing the optimum date to seed wheat. Seeding earlier or later than the optimum date may give higher sedimentation values as a result of lower yields and higher protein. But premiums obtained from wheat planted too early or too late would not usually be sufficient to offset the loss in yield nor would it compensate for other disadvantages of untimely planting.

Summary of Factors Influencing Sedimentation

1. Select reccmmended wheat varieties. They were developed and released as a result of their desirable agronomic and quality characteristics for the area in which they are recommended. Any of the Nebraska recommended varieties are capable of producing wheat which will command a sedimentation premium.

2. Seasonal moisture and temperature during the growing season will influence the quantity of protein and, thus, the sedimentation value of the wheat. Ordinarily the higher the yield, the lower the protein content. Consequently, a high yielding crop will usually have a lower sedimentation value than a low yielding crop.

3. The application of nitrogen fertilizer to wheat may increase both yield and protein per cent. Spring applications of nitrogen usually have greater effect on protein content than fall applications. Nitrogen does not always increase protein content and even if it does the sedimentation premium may not be sufficient to pay for the cost of the nitrogen.

4. Since environment plays such an important part in determining wheat sedimentation values, the grower's chances for higher sedimentation can best be improved by choosing a recommended variety and using good cultural practices.